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GROWTH AND DEVELOPMENT OF MUSCLES, BONES AND FAT OF RED-NECKED OSTRICH (STRUTHIO CAMELUS CAMELUS)

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ABSTRACT: *This study was conducted to evaluate the growth pattern of muscles, bones and fat of red-necked ostrich. Six ostrich chicks were captured and reared for 40 weeks and serial slaughters were done every eight weeks for evaluation. Results showed that the feed conversion ratio was 1: 5, Feed intake reached a peak at the 23rd week of age (161 days). The weight gain was high during the 16th week of age (112 days). Carcass yield was 57%. The great mass of muscle was found in the hind limb, highest bone percentage was found in the pelvis and the flank had high percentage of fat. Hind limb had high growth rate when compared with thorax, pelvis, wing, neck and flank*

Keywords: *carcass yield, body regions, serial slaughter*

ORIGINAL ARTICLE

INTRODUCTION

Growth is often measured as live weight gain per unit time; live weight could be a useful measure of growth as it is highly predictive of the amount of desirable edible products such as muscles. Carcass weight is more useful than live weight and the components of the carcass when measured, give a true picture of the benefit from the animal. Carcass composition is measured by the proportion of components, muscles, bones, fat and connective tissues.

Factors that affect carcass composition are slaughter, breed or genetic differences, sex and plane of nutrition, Nheta et al. (1997) said that sex has no effect on the growth rate of birds. The carcass is the most important unit in meat studies, since it finally settles the value of the meat animal, both for the farmer and the butcher, (Callow, 1948). The muscle is the most important tissue in the animal because it is most desired by the consumers. The superior carcass has a maximum yield of muscle, minimum of bone and an optimum amount of fat (Berg and Butterfield, 1976). Hammond (1932) stated that during their lives animals have two sets of muscles; early developing and late developing ones. So there must be causes for the changes in the proportion of individual muscles as animals grow. The growth of muscles can be measured by comparison of weights of the individual muscles on serial animal slaughters, and dissected throughout the lifespan of homogenous animals (weight, breed and sex) raised on a similar plane of nutrition. This method compares the percentage values of weight of individual muscles or muscle groups relative to total muscle weight at various stages of development (Berg and Butterfield, 1976). The growth patterns of the tissues show that the bones growing at a steady, but slow rate, the muscle grow relatively fast, so that the ratio of muscle to bone increases. In poultry the first ossification takes place 12 – 24 hours later in the form of laminae of bone which eventually fuse to form a thin, compact cylinder which is the periosteal bone collar (Hall, 1987). Long bone growth is a complex process which takes place in the growth plates located at the end, it consists of cartilage cells which form a template over which bone is laid. Fat is the most variable tissue in the carcass and it varies even in its partitioning among various depots and alters markedly throughout growth; therefore it has the greatest influence on both the amount of each of the other tissues in the carcass at any particular weight and the proportionate size of cuts. Fat comprises a relatively small amount of the carcass at birth and then increases so that it approaches and occasionally in very fat animals surpasses muscle tissues in absolute amount, (Berg and Butterfield, 1976).

Ostriches are large herbivorous, flightless birds, native of Africa, (Gegner, 2001). They were adapted to live in open arid countries. Their longevity is up to 75 years with an average of 50 years. Adult males can reach eight feet

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of height and weighing about four hundred bounds. The male has a black color with white wing tips and tail plumes. The female is smaller than the male with a grey color. Ostriches live in flocks of five to fifty in the wild and can do well under captivity (Donegan, 2002).

The early rate of growth of ostrich chicks is important in establishing the bird for subsequent growth up to slaughter mass. Hatching weight is dependent on the initial egg mass from which the bird emerges. After hatching, ostrich chicks lose up to 20% of their mass within five to seven days (Deeming, 1999). Goonewardene et al. (2003) studied the growth characteristics of emus compared with broilers and said that the mature weight of emus were estimated to be 49.5 kg and broilers were estimated to be 4.6 kg. The lifetime absolute growth rate of emus was 68.4 gram/day, and they matured 12.5 times slower than broilers, they concluded that growth efficiency of emus is poor and the feed cost per kilogram of gain is high, because emus are slaughtered late. Champion and Weatherly (2000) found that the peak rate of growth in ostrich is between 120 to 180 days of age when they are fed under grazing system, and the ostrich growth has a rapid decline after 10 to 11 months of age. Deeming and Ayres (1994) found that the growth rates of ostrich chicks in captivity were correlated with their weight on day ten of age and concluded that the growth of the ostriches appeared to be influenced by environmental factors. The genotype has a great influence on the carcass yields of ostrich. Hoffman et al. (2007) studied this effect in three different subspecies of ostrich which were South African Black, Zimbabwean Blue-necked and Zimbabwean Blue-necked X South African Black. They found that the live weight (100.9±4.2) and carcass weight (51.6±1.1 kg) were high in Zimbabwean Blue-necked and the dressing percentage was not differing significantly among the three subspecies. Harris et al. (1993) studied the carcass yield of ostrich and found that on the live weight basis the dressing percentage was 58.59%, and then they found that in further dissection the percentages of lean, fat and bone were 62.5%, 9.2% and 26.9% respectively. Also they found that the largest portion (34.6%) of the ostrich carcass was the semi-boneless leg and thigh; they comprise the majority of the muscle mass. Morris et al. (1995) said that the average percentage of ostrich carcass weight could reach 57-58% of the live body weight of 100-130 kg carcass composition consists of more than 62% lean meat and 9% fat, the majority of the lean portion of the ostrich carcass is found in the leg and thigh muscles (41.4%) and sex appears to has no effect on carcass composition or muscle color, total pelvic muscle mass (considering both limbs and assuming symmetry) of the ostrich was found to account for 33.7±2.1% of the body mass, corresponding to a unilateral mean pelvic limb muscle mass of 16.97±1.08 kg for a 105 kg ostrich live weight (Smith et al., 2006).

MATERIALS AND METHODS

Six red-necked ostrich chicks at approximate age of four to six weeks were captured from Dindir National Park, Sinnar State, 560 km south east Khartoum, Sudan. The birds were transported to the faculty of Animal Production–Elmanagil, University of Gezira, where this study was done. The six experimental captive chicks were lodged in a house of dimensions 7x9x3 m. The house was well protected using a mesh-wire of fine openings set over a half – meter brick wall up to the roof height which is made of corrugated metal. The ground was gritless concrete. The pen was equipped with two one-gallon flat plastic containers as feeders and waterers. When the birds reached the age of 16 weeks, they were transferred to an open pen of dimensions 10x15 m. surrounded with a brick wall 1.5 m. high and equipped with bigger feeders and waterers. Experimental birds were phase-fed with starter, grower and finisher rations (Tables 1 and 2).

The starter ration was a commercial broiler starter ration (20% crude protein and 11.65 MJ/kg metabolizable energy) fed for two weeks as adaptation feeding. The formula feed were the grower ration (17.15% crude protein and 8.55 MJ/kg metabolizable energy) which was fed for 24 weeks before the finisher ration (16.10% crude protein and 5.99 MJ/kg metabolizable energy) was fed for 12 weeks when experimental feeding was concluded. Ingredients for these rations were dura, groundnut cake, wheet bran, groundnut hulls, lucern and ostrich concentrate that is formulated by adding a premix of bone meal, fish meal and salt 6:3:1 respectively to a commercial broiler concentrate in a 1:1 ratio (Faki, 2001).

Table 1 - Percent composition (fresh weight basis) of ostrich experimental rations

Ingredients%	Starter	Grower	Finisher
Dura	70	40	20
Groundnut cake	18	08	06
Wheat bran	05	15	14
Groundnut hulls	-	24	44
Lucerne	-	05	10
Ostrich concentrate*	-	08	06
Broiler concentrate	05	-	-
Vitaminerals mix	02	-	-
Total	100	100	100

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Table 2- Percent chemical composition (dry-matter basis) of ostrich experimental rations

Components %	Starter	Grower	Finisher
Dry matter	95.00	91.58	91.37
Crude protein	20.00	16.25	14.32
Ether extract	3.26	3.20	3.13
Crude fiber	12.05	21.00	33.30
Nitrogen-free extract	40.2	45.10	34.04
Ash	07.31	6.03	6.56
Energy (MJ ME/kg)	11.65	08.55	05.99
Energy/protein ratio	01.82	01.91	02.39

Feed intake was recorded on the first day of experimental feeding and thereafter on daily basis by difference between offered and refusal. Weekly body weights were recorded to the nearest 0.5 kg at 7:00 am before feeding, using a small ruminants' balance for the starter/grower chicks and a ground level pressure balance for the grower/finisher birds. One bird was randomly selected for slaughter every eight weeks for carcass analysis and muscle groups study. The bird was allowed water but not feed for the last 12 hours before slaughter. The bird was first controlled using an S-shaped neck-catch before hooding the head with a black cloth. The legs were tied immediately to restrict the bird movement. Slaughter weight was recorded. The bird was hung by the legs to the slaughter arch allowing the head closer to the ground (Figure 1). The slaughter followed the Muslim practice. The right and left jugular veins and carotid arteries were severed by a sharp knife just behind the head. After complete bleeding; the blood was collected and weighed.

Feathers were manually plucked, collected and weighed. The head was removed at its occipito-atlantal articulation and weighed. The bird was dressed by making a longitudinal ventral incision extending from the neck up to the cloaca with lateral right and left incisions to the wings and legs at right angles. The skin was then removed and weighed. The bird was reversed and hooked by the wings. The feet were removed at the tibiotarsal (hock) joint and weighed. A longitudinal ventromedial incision from the breast down to the abdomen was made to eviscerate the abdominal organs and empty the thoracic cavities. The tissues and organs; heart, lungs, trachea, esophagus, gastrointestinal tract, liver, spleen, left and right kidneys, cavity fat and genitals were each individually removed and weighed. The hot carcass was weighed first and the neck was removed at the last cervical vertebra. The hot carcass was then divided into right and left halves by sawing along the vertebral column. The left side was divided into six regions; hind limb, pelvis, flank, thorax, neck and wing. Each region was separated from the other by separating entire muscles from either origin or insertion. Each region was dissected to separate muscles, bones, connective tissues and fat, and each of the above regional tissues weight was recorded. The carcass, divided parts and dissected tissues, were all kept under wet towels to prevent evaporation and dryness.

RESULTS AND DISCUSSION

Average performance values of the red – necked ostrich of the final slaughter are shown in Table 3. Final weight was 66.0 kg and the feed conversion ratio was approximately 1:5. Aganga and Omphile (2003) said that ostriches have very efficient feed conversion ratio during the first thirty weeks until 45 weeks of age before a drop in feed conversion ratio occurred. In this study the same result was obtained and the feed conversion ratio was found to be 1:5 during 38 weeks of age.

Table 3 - Performance values (Kg) of the red–necked ostrich raised to 40 weeks of age

Item	Value
Initial weight	6.8
Final weight	66.0
Daily weight gain	0.350
Daily feed intake	1.669
Feed conversion ratio	1:5

Figure 1 illustrate the feed intake and weight gain of the ostrich raised to the final slaughter weight at 40 weeks of age. Feed intake reached a peak at the 23rd week of age (161 days). This result is similar to that found by Waugh et al. (2006) who reported the feed intake in ostrich gradually increased until 170 days of age (24 weeks of age) when it reached a peak. The weight gain of ostrich was found to be highest during the 16th week of age (112 days). This result nearly agrees with that found by Champion and Wetherly (2000) who found that the peak rate of growth in ostrich is between 120 to 180 days of age under the grazing system. The slight difference between the two results may be due to the better pattern of growth achieved in this study adopting captive intensive feeding.

The slaughter weights of the six serial slaughters (every 8 weeks) were 7.00, 10.00, 23.6, 37.00, 61.00, and 66.00 kg (Figure 2).

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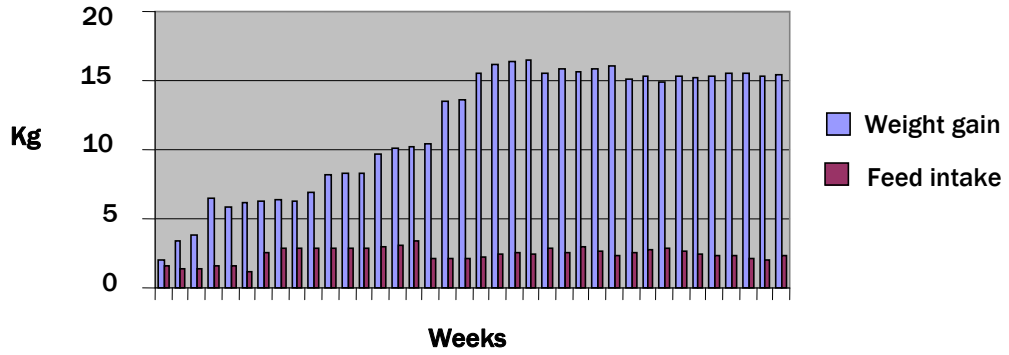

Figure 1 - Average values of feed intake and weight gain (Kg) of red–necked ostriches raised to 40 weeks of age

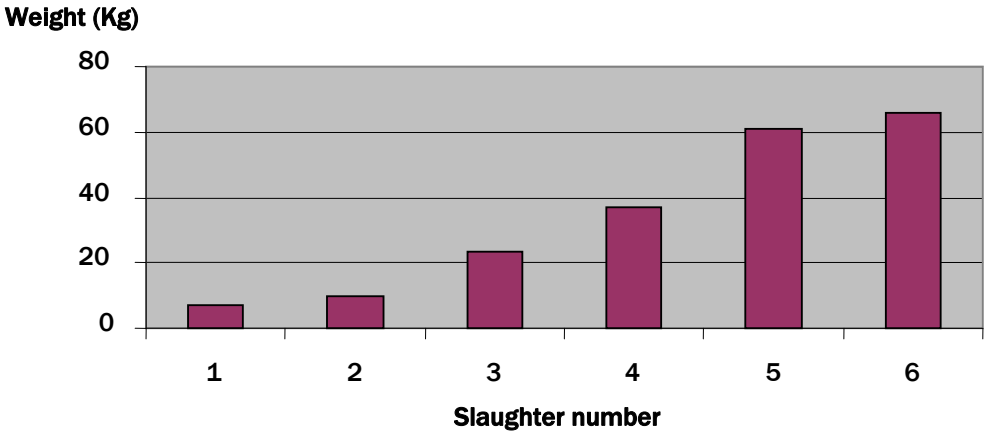

Figure 2 - The slaughter weights of the six serial slaughters of the red-necked ostriches

The hot carcass weights of the six slaughters are shown in Figure 3. Hot carcass weights were 2.59, 3.93, 11.70, 20.55, 35.00 and 37.50 kg. At the final slaughter (38 weeks of age) the carcass weight was 37.5 kg when the live weight was 66 kg, i.e. the dressing percentage was 57%. The dressing percentage obtained by Harris et al. (1993) was 58.6% which is close to the result recorded in the present study.

Figure 3 - The hot carcass weights of the six serial slaughters of the red-necked ostriches

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Table 4 shows body regions absolute weights (kg) and their percentages from the left side weight and their tissues percent of the left side region weight at last serial slaughter. The hind limb comprised the highest percentage from the left side of the carcass (70%) and the flank had the lowest percentage which is 3%. The hind limb had the greatest mass of muscle (76%), and lowest fat contents (3%). The highest bone content was found in the pelvis (54%), but the hind limb had a lowest bone percentage (15%) and the flank is boneless. Most connective tissues were found in the flank followed by the wing and the flank had the highest (9%) fat content. The total muscle, fat and bone percentages of the six regions were 54, 5.8 and 26.6 respectively, this result was similar to that found by Harris et al. (1993) who found the total percentage of lean, fat and bone to be 62.5, 9.2 and 26.9 respectively.

Figure 4 shows average development values (kg) of different body region weights on serial slaughters of the red–necked ostriches. The growth rate of the hind limb was the highest of all other regions. This result was similar to that found by Harris et al. (1993) and Morris et al. (1995) who said that the majority of the lean portion of the ostrich carcass is found in the leg and thigh muscles (41.4%).

Table 4 - Body regions absolute weights (kg) and their percentages from the left side weight and their tissues percent of the left side region weight at last serial slaughter.

Region	Weight	Percentage	Muscle %	Bone %	Connective tissue %	Fat %
Pelvis	1.300	7	38	54	4	4
Thorax	1.500	8	43	47	3	7
Flank	0.600	3	58	-	33	9
Hind limb	13.500	70	76	15	6	3
Wing	0.700	4	43	36	21	0
Neck	1.600	8	66	34	6	0

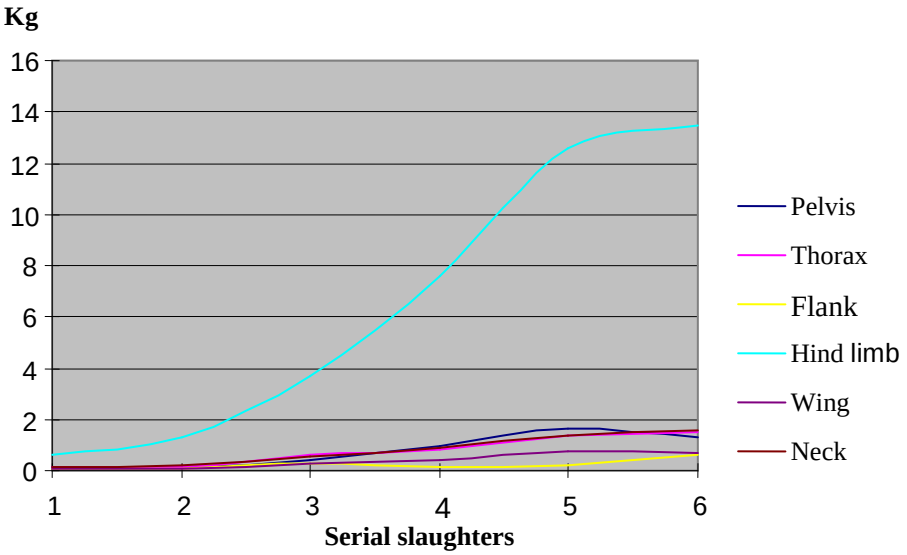

Figure 4 - Average development values (kg) of different body region weights on serial slaughters of the red–necked ostriches

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